STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX M

DICHOTOMOUS SAMPLER

MONITORING AND LABORATORY DIVISION

FEBRUARY 1997

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AIR RESOURCES BOARD

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VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX M.1

STATION OPERATOR'S PROCEDURES

FOR

DICHOTOMOUS SAMPLER

MONITORING AND LABORATORY DIVISION

FEBRUARY 1997

M.1.0 GENERAL INFORMATION

Sierra Instruments Model 244 Dichotomous Sampler collects particulate matter 15 microns and less from the ambient air. The Sierra-Andersen Model 246 10-Micron Inlet retrofits on all existing Dichotomous Samplers Model 244 and brings them into compliance with the U.S. EPA's PM10 Federal Reference method. The combination of Sierra Instruments' Dichotomous Sampler Model 244 and Sierra-Andersen Model 246(10-Micron Inlet) is the Sierra-Andersen Model 241 Dichotomous Sampler. Model 241 collects suspended particulate matter 10 micrometers and less (aerodynamic diameter) from ambient air. Particulate matter of 10 micrometers and less is termed inhalable particulate matter. Particles smaller than 2.5 micrometers are termed fine fraction. Particles between 2.5 and 10 micrometers are termed coarse fraction. Model 241 Dichotomous Sampler separates the sampled air into fine and coarse fractions. The two fractions are collected on separate particulate filters.

M.1.0.1 PHYSICAL DESCRIPTION

The dichotomous sampler consists of a sampling module and a control module.

1. Sampling Module - The sampling module (shown in Figure M.1.0.1) consists of a sample inlet, a virtual impactor particle separator, filter holders, and a tripod support. The sampling module is about 40 inches high.

   The sample inlet assembly is shown in Figure M.1.0.2. A pump located in the control module draws air into the sampler. The pump draws an ambient sample into the inlet assembly at such a velocity that particles larger than 10 micrometers settle out while the particles smaller than 10 micrometers are collected. The inlet is symmetrical and therefore, insensitive to wind direction and has been found to be relatively insensitive to wind speed.

2. Control Module - The control module contains valves for setting the sample rate, rotameters for observing the sample rate, a pump to draw the sample, a flow controller to keep the sampling rate constant, an automatic timer to start and stop sampling, and an elapsed time recorder. The control module is 14" high by 16" wide by 19" deep. The front panel of a typical control module is shown in Figure M.1.0.3.

   NOTE: Your control module may or may not have a pressure switch or recorder and may differ slightly from Figure M.1.0.3. Some Model 241 samplers have a Dickson chart recorder mounted on the end of the cabinet, as shown in Figure M.1.0.3. The recorder is used to determine continuity of flow and any fluctuations during the 24-hour run, and is not used quantitatively to measure flow.

The two rotameters are used to measure the total flow and coarse fraction flow. They are set to points determined by rotameter calibration. The air sample is drawn by a Thomas 727 CM39 diaphragm pump. The sample flow rate is kept constant by a flow controller. The flow controller throttles the fine particle flow on the inlet side of the pump using pneumatic feedback of the pressure difference across the total flow adjustment valve. The flow controller maintains a constant pressure difference keeping the flow rate constant. Figure M.1.0.4 depicts the dichotomous sampler flow.

M.1.0.2 SYSTEM OPERATION

The Dichotomous sampler draws air at an actual flow rate of 1 m/hour (16.70 actual liters/minute). Ninety percent of the air (15.03 liters/minute) flows through the fine particulate filter, and the remaining 10 percent (1.67 liters/minute) flows through the coarse particulate filter.

The dichotomous sampler uses a virtual impactor (region of stagnant air) to segregate the air sample into two fractions. The virtual impactor particle separator (shown in Figure M.1.0.5) accelerates the air sample through a nozzle and then deflects the air at a right angle. Most particles smaller than 2.5 micrometers (fine fraction) will follow the higher air flow path and collect on a fine particulate filter. Particles between 2.5 and 10 micrometers (coarse fraction) have sufficient inertia to impact into the chamber below the nozzle and are collected on a coarse particulate filter. Ten percent of the sample air flows through the coarse particulate filter and because of this, approximately 1/10 of the fine particulates are collected on the coarse particulate filter.

The coarse and fine particulate filters are 37 mm in diameter and are mounted in plastic rings. The filters are weighed to calculate mass concentrations and, where appropriate, analyzed to determine the concentration of various chemical elements.

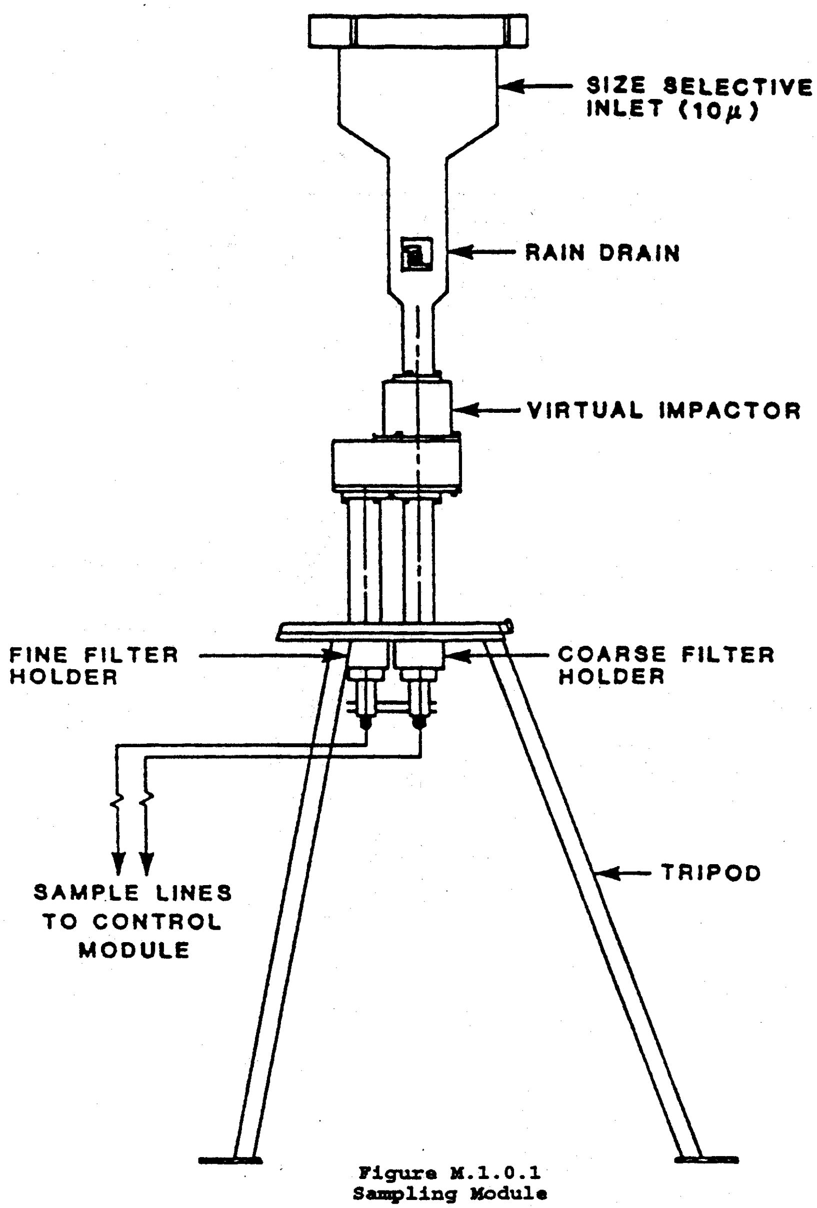


Figure M.1.0.1
Sampling Module

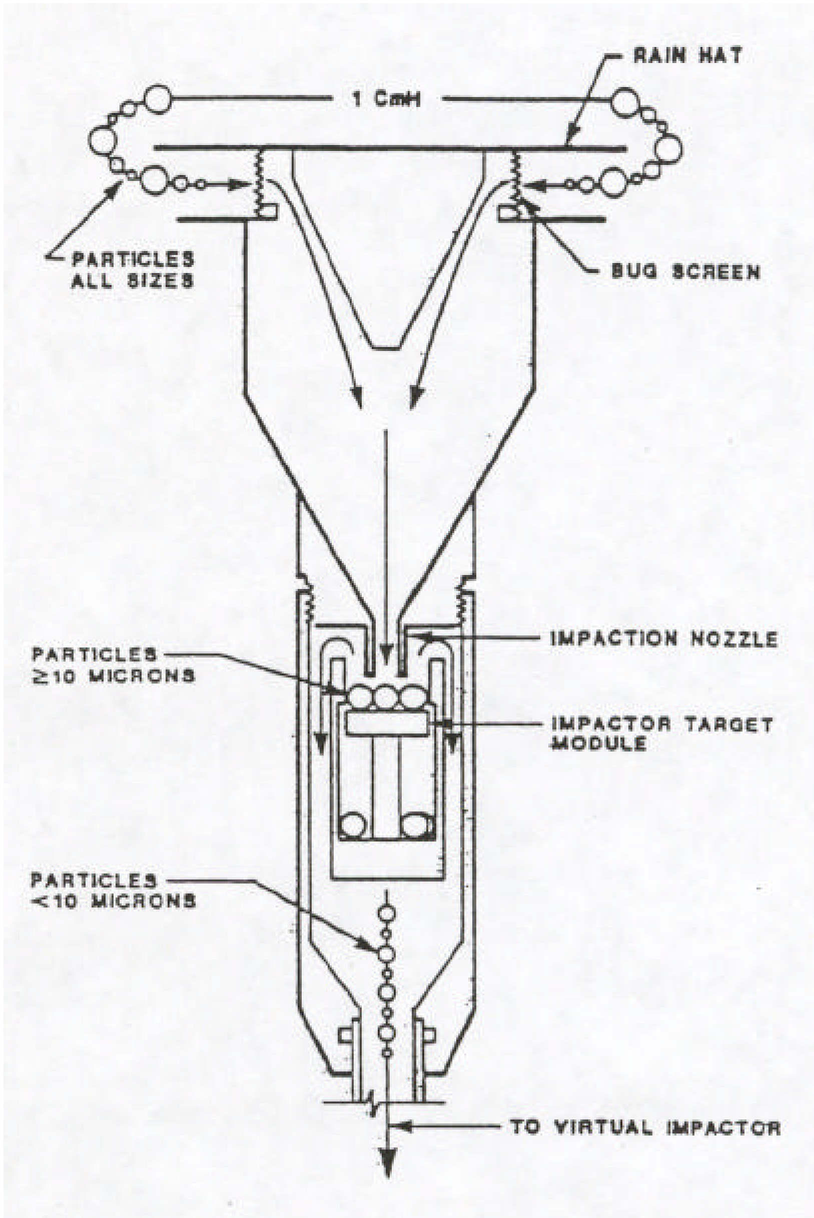


Figure M.1.0.2
Sample Inlet Assembly

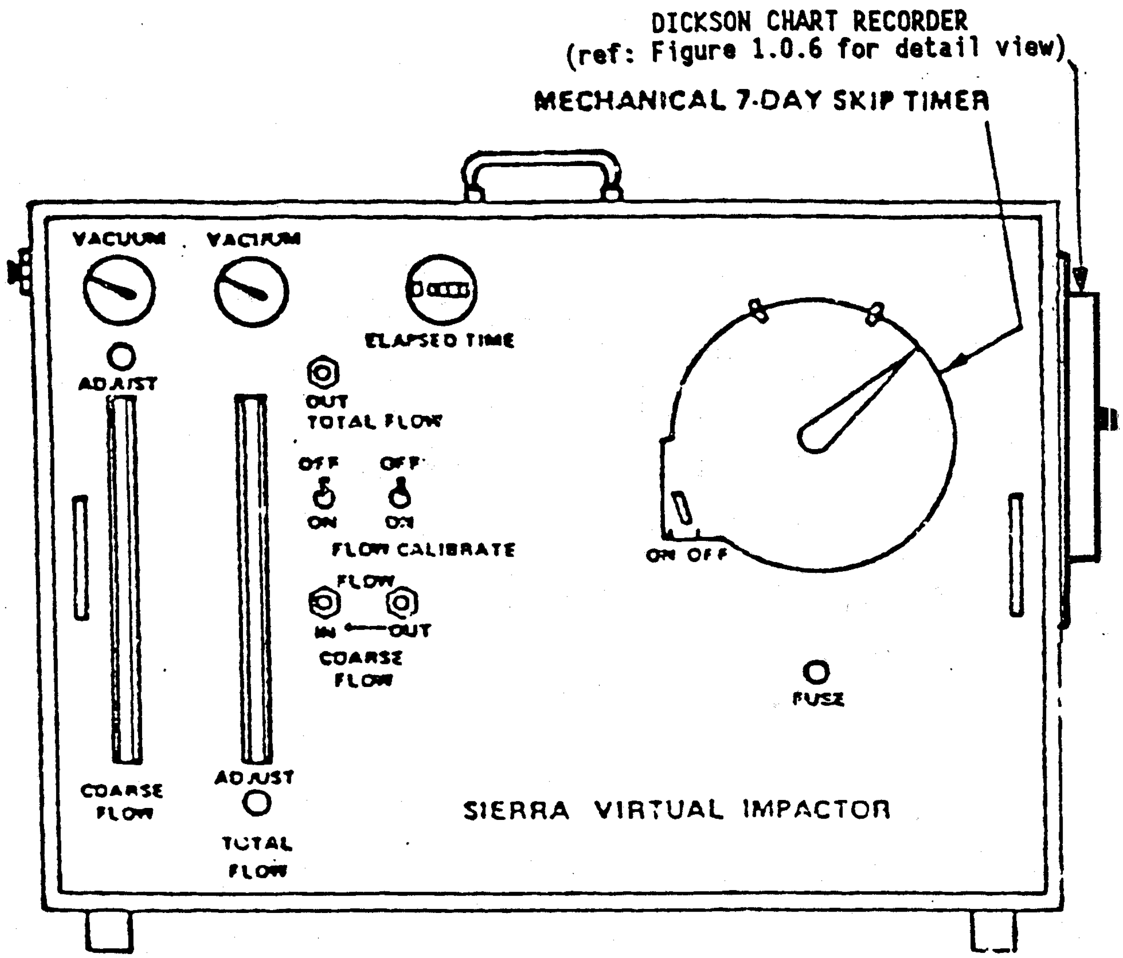


Figure M.1.0.3
Control Module For Sierra Model 244E Dichotomous Sampler

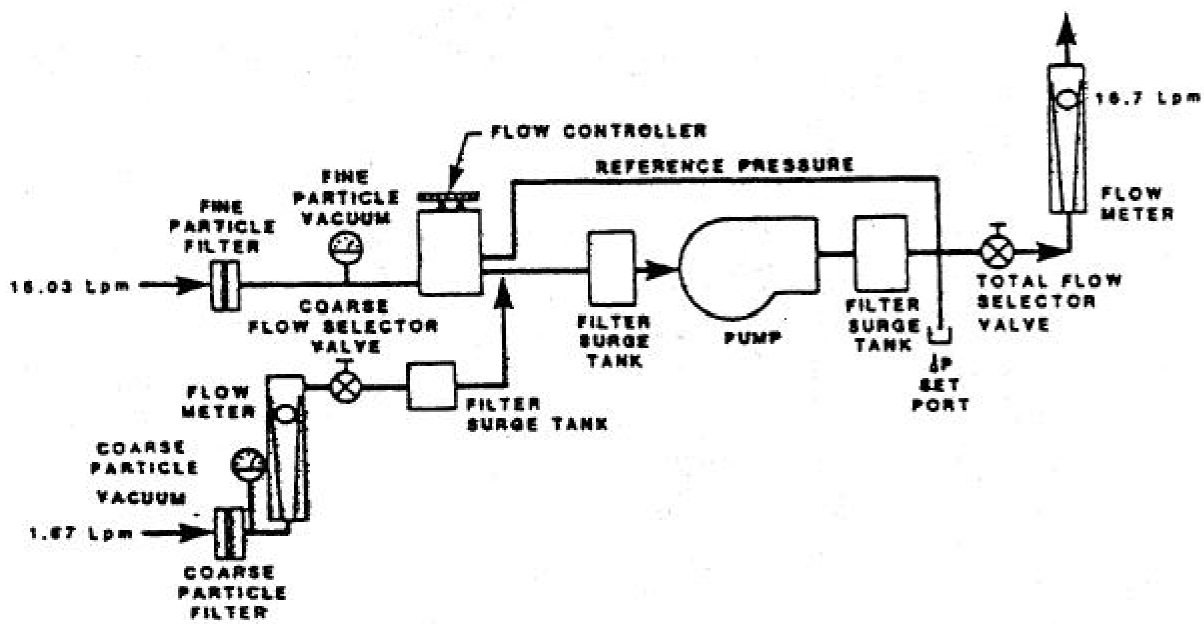


Figure M.1.0.4
Dichotomous Sampler Flow Diagram

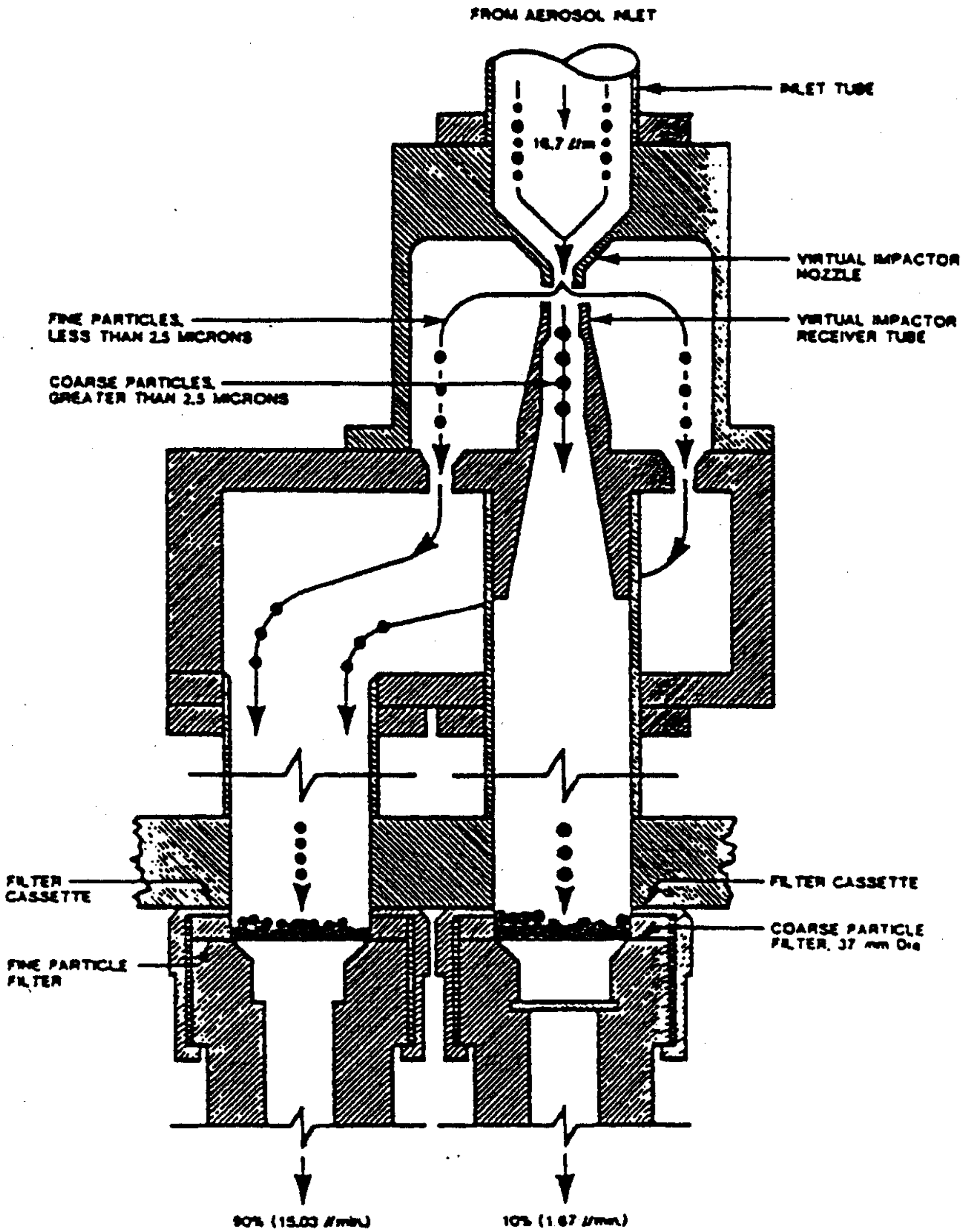
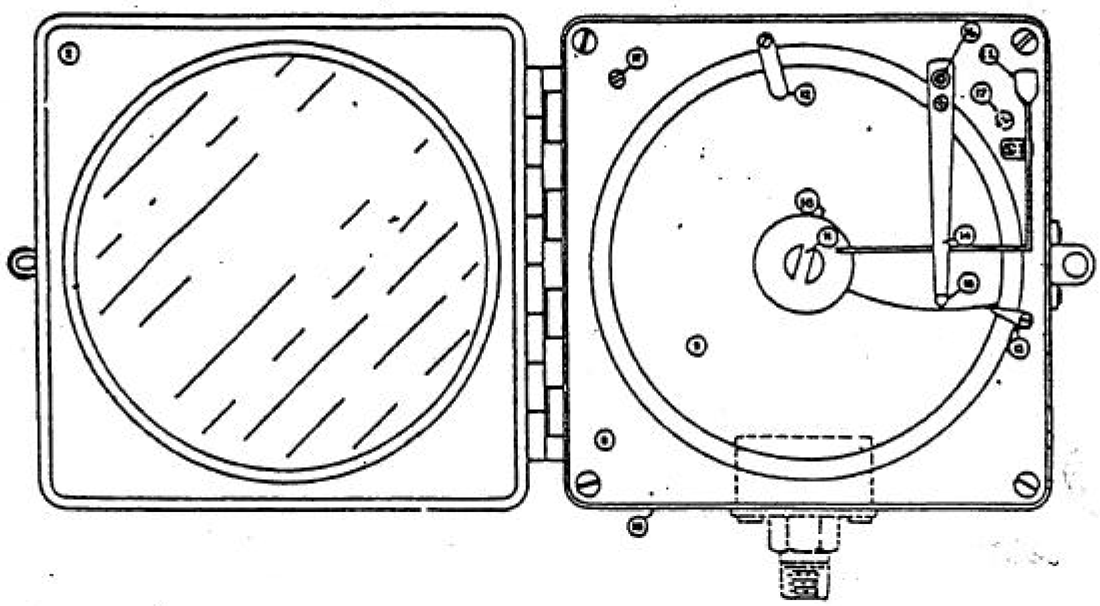


Figure M.1.0.5
Virtual Dichotomous Sampler



2. Door Assembly
8. Instrument Dial Assembly
9. Chart
10. Chart Hub
11. Chart Hub Slot
12. Chart Guide Clip
13. Time Index Clip
14. Pen Arm Assembly
15. "V" Standard Pen Point
16. Pen Arm Shaft Bracket
17. Calibration Adjustment Screw
19. Case Assembly
22. Pen Lifter

Figure M.1.0.6
Dickson Recorder

M.1.1 INSTALLATION PROCEDURES

M.1.1.1 PHYSICAL INSPECTIONS

Unpack the dichotomous sampler and check for external shipping damage. Verify the sampler is complete upon receipt and check for loose or damaged components. If components are found damaged, notify your supervisor for appropriate action.

M.1.1.2 INITIAL SET-UP

The sampling module tripod feet should be securely fastened to the roof or platform on which it is located. The sample inlet is to be fitted to the impactor assembly. The sample lines are connected from the Fine and Coarse filter holders to the control module. After installation, check the operation of the sampler by conducting rotameter calibrations as described in Appendix M.2.

M.1.1.3 SAMPLING FREQUENCY

The dichotomous sampler is normally operated every sixth day for 24 hours (midnight-to-midnight) PST on the same schedule as the high volume sampler as shown in Figure M.1.1.2.

M.1.1.4 PRE-RUN PROCEDURES

1. Filter Installation - The preweighed filters are sent to the station operators mounted in plastic filter holders (cassettes) and enclosed in plastic cases. The coarse filter cassette is yellow and the fine filter cassette is white. They are sent in pairs with identification numbers and labeled C for coarse and F for fine on the cases. The collection side of the filter is inset deeper or further away from the flat surfaces of the plastic filter holder, and the non-collection side of the filter is inset less and/or is closer to the flat surfaces of the plastic filter holder. The collection side with the filter surface inset the most, should face upward when inserted into the sampler (see Figure M.1.1.0).

   NOTE: If the filter cassettes are installed in the sampler upside down, the data collected will be invalid due to leaks and/or possible damage to the filter.

2. Rain Drain Check - If more than 1/5 of the jar by volume is full, remove the water.

3. Timer Setting - Set the status switch to "Auto." Rotate the timer clockwise until the correct (present) day and time appear at the time pointer. For initial setup and if the run times are not exactly 24 hours, set the sample start time by placing the bright (silver colored) tripper at the time sampling should begin (midnight at the start of the next high volume sampling day). Set the sample stop time by placing the dark tripper at the time sampling should stop (midnight at the end of the sampling day). Turn the main power switch on.

4. Flow Setting - Turn the sampler pump on by setting the status switch to "Manual." Adjust total and coarse flows so that the rotameter floats are at the set points established during calibration for that sampling location. Return the status switch to the "Auto" position.

5. Data Form - Assure all blanks on the "Dichotomous Sampler Data Form" (Figure M.1.1.1) are filled in except the section labeled, "FOR LABORATORY USE ONLY:". There may also be nothing filled out in the section labeled, "SAMPLING PROBLEMS:". Record the reading shown by the elapsed time meter under ELAPSED TIME METER, INITIAL. Record the values to which the rotameters were set under ROTAMETER READING: COARSE and TOTAL, INITIAL. Check that the flows were set to the correct values, and that the filter numbers agree with those on the filter cases. Also check that the two bypass toggle switches (if present) on the control module are in the "Down" position. The requested information on the "Dichotomous Sampler Monthly Quality Control Maintenance Checksheet" (Figure M.1.2.1) should also be filled in.

6. Dickson Chart Recorder (Optional) - Install a clean recorder chart for each sample period. To install a chart, the following procedure should be followed:

   a. Open the recorder door. Raise the pen arm by gently pressing the flat portion of the pen lifter. Never energize the sampler while the pen is raised; this may damage the pen arm and/or the spring inside the flow recorder.

   b. Slip a clean recorder chart beneath the pen arm and over the slotted chart drive. Make sure the chart is held by the two chart clips located on the face of the recorder.

   c. Lower the pen arm. Ensure that the recorder is properly zeroed (the pen rests on the inner most circle of the chart). Adjust the set screw (located on the bottom right corner of the recorder face) as necessary. Advance the chart to check the zero and to ensure that the pen is inking.

d. Turn the slotted drive clockwise using a coin until the correct time is indicated by the pointed chart clip. Set the time for the beginning of the next sample period.

e. Close the recorder door and engage the locking mechanism. Inspect the connecting pressure tubing inside the control module on a routine basis to insure that no crimps or cracks develop.

f. The recorder is now ready for the next sample period.

M.1.1.5 POST-RUN PROCEDURES

1. Flow Check - Turn the sampler pump on briefly. Note the rotameter readings. Turn the pump off.

2. Sampler Data Form - Record the reading shown by the elapsed time meter under ELAPSED TIME METER, FINAL. Record the values noted in step 1 above under ROTAMETER READING: COARSE and TOTAL, FINAL. For the elapsed time, subtract the INITIAL from the FINAL to get the NET elapsed time. Calculate the average of the INITIAL and FINAL rotameter readings for COARSE and TOTAL and place in the AVERAGE block. Use the calibration curve equations (slopes and intercepts) and compute the coarse and total flows in standard liters/minute (SLPM) and enter on the datasheets. Record the requested information on both the Dichotomous Sampler Data Form and the Monthly Quality Control Maintenance Checksheet.

3. Filter Removal and Shipment - Remove the coarse filter cassette (yellow colored) and the fine filter cassette (white colored) carefully. Place them in the correct plastic cases and return with the sampler data form in the envelope provided.

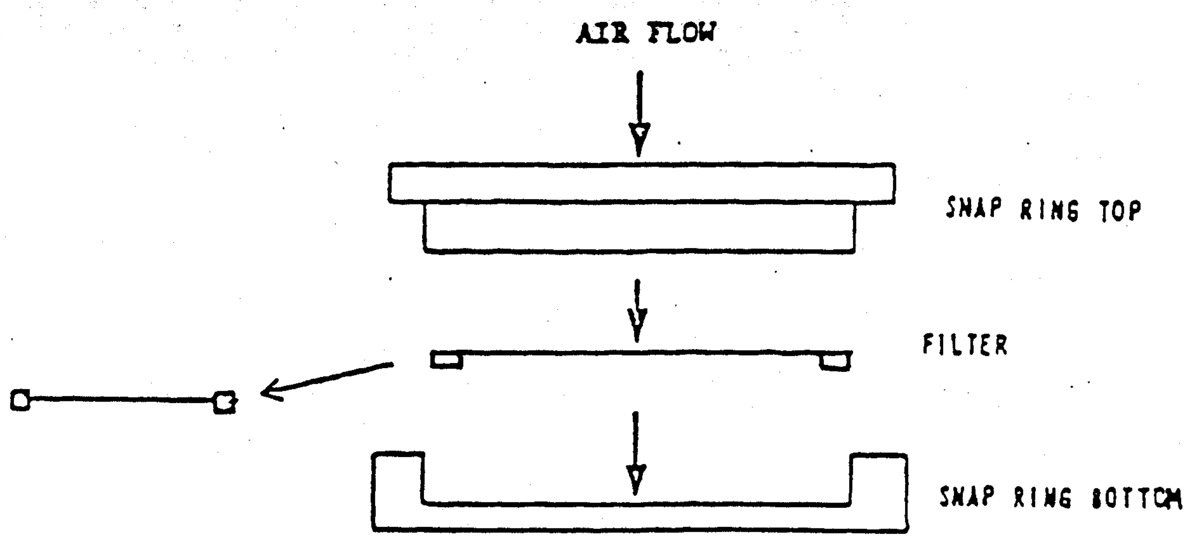


Figure M.1.1.0
Filter Cassette Assembly

DICHOTOMOUS PM10
24-HOUR REPORT FORM

LAB. NO.

STATION NAME	ELEVATION
REPORTING AGENCY	
STATION ADDRESS	
STATION OPERATOR	
OPERATOR PHONE #	

COUNTY SITE AGENCY PROJECT

INSTRUMENT NO.

SAMPLE DATE YEAR MONTH DAY

FILTER SET #

LOCAL CONDITION CODE (ENTER CODE IN BOX AT RIGHT)

A: NO UNUSUAL CONDITIONS B: WIND-BLOWN DUST/SAND
C: CONSTRUCTION NEARBY D: FARMING NEARBY
E: FIRE NEARBY H: RAIN
I: SNOW J: OTHER

SAMPLING CONDITION

SAMPLING PROBLEMS: (EXPLAIN IN COMMENTS)

	YES
FILTERS DAMAGED:	
DURING SAMPLING?	☐
AFTER SAMPLING?	☐
SAMPLER MALFUNCTION?	☐
MALFUNCTION REPAIRED?	☐
POWER OUTAGE:	
FOR MORE THAN 1 HR?	☐
FOR LESS THAN 1 HR?	☐

DATE OF LAST CALIBRATION: YEAR MONTH DAY

ROTOMETER READING: COARSE
INITIAL
FINAL
AVERAGE

ROTOMETER READING: TOTAL
INITIAL
FINAL
AVERAGE

ELAPSED TIME METER
FINAL MIN
INITIAL MIN
NET MIN

DETERMINATION OF TOTAL STANDARD FLOW RATE IN SLPM:

ROTOMETER READING AVERAGE (TOTAL FLOW) X SLOPE (TOTAL FLOW) ± INTERCEPT (TOTAL FLOW) = TOTAL FLOW IN SLPM

COMMENTS:

FOR LABORATORY USE ONLY:

	COARSE	FINE	CDUP	FDUP
GROSS				
TARE				

RECEIVED AT ARB LAB

ON:

REMARK:

MLD 16 (4/93) REV. 4/93

Figure M.1.1.1
Dichotomous Sampler Data Form

2001 Monitoring Schedule

1/6-Day &1/3-Day Monitoring Schedule for TSP, Pb, PM-10, PM-2.5, and VOC

$\boxed{}$ = 1/6 schedule

January

Su	M	Tu	W	Th	F	Sa
	$\boxed{1}$	2	3	4	5	6
$\boxed{7}$	8	9	10	11	12	$\boxed{13}$
14	15	16	17	18	$\boxed{19}$	20
21	22	23	24	$\boxed{25}$	26	27
28	29	30	$\boxed{31}$			

February

Su	M	Tu	W	Th	F	Sa
				1	2	3
4	5	$\boxed{6}$	7	8	9	10
11	$\boxed{12}$	13	14	15	16	17
$\boxed{18}$	19	20	21	22	23	$\boxed{24}$
25	26	27	28			

March

Su	M	Tu	W	Th	F	Sa
				1	$\boxed{2}$	3
4	5	6	7	$\boxed{8}$	9	10
11	12	13	$\boxed{14}$	15	16	17
18	19	$\boxed{20}$	21	22	23	24
25	$\boxed{26}$	27	28	29	30	31

April

Su	M	Tu	W	Th	F	Sa
$\boxed{1}$	2	3	4	5	6	$\boxed{7}$
8	9	10	11	12	$\boxed{13}$	14
15	16	17	18	$\boxed{19}$	20	21
22	23	24	$\boxed{25}$	26	27	28
29	30					

May

Su	M	Tu	W	Th	F	Sa
		$\boxed{1}$	2	3	4	5
6	$\boxed{7}$	8	9	10	11	12
$\boxed{13}$	14	15	16	17	18	$\boxed{19}$
20	21	22	23	24	$\boxed{25}$	26
27	28	29	30	$\boxed{31}$		

June

Su	M	Tu	W	Th	F	Sa
					1	2
3	4	5	$\boxed{6}$	7	8	9
10	11	$\boxed{12}$	13	14	15	16
17	$\boxed{18}$	19	20	21	22	23
$\boxed{24}$	25	26	27	28	29	$\boxed{30}$

July

Su	M	Tu	W	Th	F	Sa
1	2	3	4	5	$\boxed{6}$	7
8	9	10	11	$\boxed{12}$	13	14
15	16	17	$\boxed{18}$	19	20	21
22	23	$\boxed{24}$	25	26	27	28
29	$\boxed{30}$	31				

August

Su	M	Tu	W	Th	F	Sa
			1	2	3	4
$\boxed{5}$	6	7	8	9	10	$\boxed{11}$
12	13	14	15	16	$\boxed{17}$	18
19	20	21	22	$\boxed{23}$	24	25
26	27	28	$\boxed{29}$	30	31	

September

Su	M	Tu	W	Th	F	Sa
						1
2	3	$\boxed{4}$	5	6	7	8
9	$\boxed{10}$	11	12	13	14	15
$\boxed{16}$	17	18	19	20	21	$\boxed{22}$
23	24	25	26	27	$\boxed{28}$	29
30						

October

Su	M	Tu	W	Th	F	Sa
	1	2	3	$\boxed{4}$	5	6
7	8	9	$\boxed{10}$	11	12	13
14	15	$\boxed{16}$	17	18	19	20
21	$\boxed{22}$	23	24	25	26	27
$\boxed{28}$	29	30	31			

November

Su	M	Tu	W	Th	F	Sa
				1	2	$\boxed{3}$
4	5	6	7	8	$\boxed{9}$	10
11	12	13	14	$\boxed{15}$	16	17
18	19	20	$\boxed{21}$	22	23	24
25	26	$\boxed{27}$	28	29	30	

December

Su	M	Tu	W	Th	F	Sa
						1
2	$\boxed{3}$	4	5	6	7	8
$\boxed{9}$	10	11	12	13	14	$\boxed{15}$
16	17	18	19	20	$\boxed{21}$	22
23	24	25	26	$\boxed{27}$	28	29
30	31					

Figure M.1.1.2
Dichotomous Sampling Schedule

M.1.2 ROUTINE SERVICE CHECKS

M.1.2.1 GENERAL INFORMATION

Perform the following checks at the intervals specified in the service schedule (Table M.1.2.1). Checks may be performed more frequently but should be performed at least at the prescribed intervals. The Monthly Quality Control Maintenance Checksheet (Figure M.1.2.1) should be completed and forwarded to your supervisor.

CAUTION: Whenever the front panel of the control module enclosure is removed, first unplug the line power cord from its receptacle.

M.1.2.2 EACH RUN

Check and record the requested information on the Dichotomous Sampler Data Form and the Monthly Maintenance Quality Control Checksheet.

M.1.2.3 MONTHLY CHECKS

Perform the following procedures once a month.

1. Check the complete system, tubing, and fittings for leaks as follows:

    a. Install blank coarse and fine filters.

    b. Remove the sampler inlet assembly and insert a leak/flow adaptor on the impactor tube. Close the adaptor to prevent any flow.

    c. Turn on the vacuum pump. Within a minute, the coarse and fine vacuum gages should stop rising. They should read at least 20 inches of Hg. For sites under 1,000 feet, the gages should reach as much as 25 inches of Hg. Record the readings on the checksheet.

    d. Shut off the pump and start a 60-second countdown. The vacuum gages should not drop to 9 inches of Hg within the 60-second countdown. Record the readings after 60 seconds on the checksheet. An initial decrease to 12 to 15 inches Hg is not caused by external leaks but rather by a small flow through the feedback line from the compressor to the vacuum side of the pump. If either vacuum gage drops below 5 inches of Hg in 60 seconds, there is a leak which should be repaired prior to the next sampler run.

    NOTE: Filter jars are often leakage areas, and some pumps tend to leak. A leaky pump can be identified by plugging the output port marked

"OUT/CALIBRATE" immediately after turning the pump off. If the rate of decline is slowed, then the system is acceptable.

e. After all pressures return to atmospheric, remove the rubber stopper. If the rubber stopper is removed too early, filters may be damaged.

2. Check the sampler total flow. With the leak/flow adaptor and blank filters still installed, after the leak check, proceed as follows:

   a. Install tubing between the leak/flow adaptor and the calibrated Vol-O-Flo capable of measuring the 16.7 SLPM expected.

   b. Turn the sampler on. Allow at least 5 minutes warm-up and then adjust the total and coarse rotameters to the set points determined during the last calibration.

   c. Record the Total rotameter reading in the (Ind.) block of the Maintenance Checksheet. Enter the Vol-O-Flo slope and intercept and calculate the SLPM.

   d. If the calculated flow deviates by more than $\pm$8.0% from 16.70 LPM, corrective action must be taken and the calibration staff notified. To convert SLPM to LPM, divide SLPM by the altitude correction factor (ACF) or multiply SLPM by the Temp./Pressure correction factor (TPC) found on the last calibration report.

   e. Remove the leak/flow adaptor and filters and set up the sampler for the next run.

M.1.2.4 SEMI-ANNUAL CHECKS

1. Disassemble and clean the sample inlet, virtual impactor, and filter holders. Be sure to include the nozzle, using n-Propyl alcohol and lint-free paper towels and cotton swabs (see Figure M.1.2.2). Check and replace the O-rings as required.

   NOTE: In extremely dirty environments, wash the module first with detergent and rinse with water. For more detailed instructions on cleaning and repairing the sampling module, virtual impactor assembly, and the control module (pump box), reference Section M.1.3.

2. Check all tubing and replace if excessively dirty, discolored, cracked, chafed, or kinked.

3. Perform Total and Coarse flow rotameter calibrations. Record data on the calibration form (Figure M.2.1.1). See Section M.2.0 for details.

M.1.2.5 AS REQUIRED CHECKS (Dickson Recorder)

To replace the pen, follow the steps listed below:

1. Lift the pen arm by pressing gently the flat portion of the pen lifter.

2. Slide the old cartridge off the pen arm, being careful not to bend the arm.

3. Lay the new cartridge on the pen arm with the tip centered in the Vee cut.

4. With the forefinger and thumb, deflect the hinged retainer spring and snap it into the engaged position around the pen arm.

Table M.1.2.1

Maintenance Schedule for the Dichotomous Sampler

	EACH RUN	MONTHLY	SEMI-ANNUAL
Check and Record the Requested Information on the Dichotomous Sampler Data Form and the Monthly Quality Control Maintenance Check Sheet	X		
Perform System Leak Check		X	
Perform Total Flow Check		X	
Clean Sample Inlet, Virtual Impactor, and Filter Holders			X
Check and Replace O-rings as Needed			X
Check all Tubing, Replace as Necessary			X
Perform Total and Coarse Flow Calibrations			X

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET
DICHOTOMOUS SAMPLER

Station Name: ______________________ Month/Year: ______________________

Station Number: ______________________ Operator: ______________________

Sampler Property Number: ______________ Agency: ______________________

Date		Filter Set Number	Rotameter Reading				Elapsed Time Meter		Calculated Average Flows		Comments on Local Condition
			Coarse		Total						
Run	Ship		Initial	Final	Initial	Final	Initial	Final	Coarse	Total	

OPERATOR INSTRUCTIONS:

1. Each Run: Check and record the above listed information. The calculated average flows are determined by adding the initial and final rotameter readings for coarse and total flows and dividing by two. This figure is then multiplied by the slope and intercept given below in the semi-annual section below.

2. Monthly: Perform a leak check and a Total flow check. Date last checked: ________
Initial Vacuum: Fine=____ Coarse=____ After 60 secs.: Fine=____ Coarse=____
Flow: (Ind.)______X(Voloflow slope)______ ±(Volo. intercept)______=______slpm

3. Semi-Annual: Clean Sample Inlet, Virtual Impactor, Filter Holders, and O-Rings. Date last cleaned: ________ Check all tubing for wear and cleanliness. Perform Total and Coarse flow rotameter calibrations. Date last calibrated: ________
Total: Setpoint = ______ Slope = ________ Intercept = __________
Coarse: Setpoint = ______ Slope = ________ Intercept = __________

4. As Needed: Replace O-Rings if cracked or nicked. Replace tubing if excessively dirty or hardened enough to crack. Date tubing last replaced: ________

Date	Comments or Maintenance Performed

Reviewed By: ______________________ Date: __________

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Figure M.1.2.1
Monthly Quality Control Maintenance Checksheet

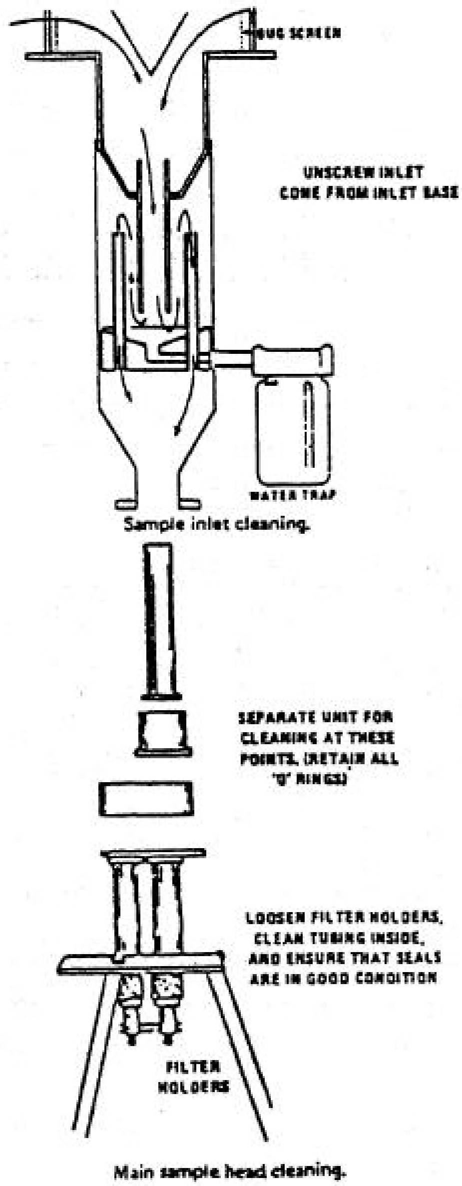


Figure M.1.2.2
Dichotomous Sampler Cleaning

M.1.3 PREVENTIVE MAINTENANCE PROCEDURES

Preventive maintenance is defined as a program of positive actions aimed towards preventing failure in monitoring and analytical systems. The overall objective of a routine preventive maintenance program is to increase measurement system reliability and to provide for a more complete data acquisition.

M.1.3.1 MAINTENANCE PROCEDURES

Recommended Supplies for Maintenance Procedures: Alcohol or general purpose detergent, cotton swabs, a small, soft-bristle brush, paper towels, distilled water, and miscellaneous handtools are required maintenance supplies for dichotomous samplers. A compressed-air source is recommended, but not required: Inert gas (tech spray) obtainable from stock room.

M.1.3.2 SAMPLING MODULE

The sampling module of the dichotomous sampler consists of a sampler inlet and virtual impaction assembly. Figure M.2.1.6 shows a disassembled sampling inlet, and Figure M.2.1.7 illustrates the virtual impaction assembly. All parts are sealed with "O" rings.

To dismantle the inlet sampler:

1. Mark each assembly point of the inlet sampler with pen or pencil to provide "match marks" during reassembly.

2. Disassemble the unit in accordance with the manufacturer's instructions, taking care to retain all "O" rings and miscellaneous parts.

   NOTE: If assembly screws appear to be frozen, the application of penetrating oil or commercial lubricant will make removal easier.

3. Clean all interior surfaces with general purpose cleaner or compressed-air source, paying particular attention to small openings and crevices. Cotton swabs and/or a small brush would be most helpful in these areas. Completely dry all components.

   NOTE: The inlet tube may be corroded. The aluminum has been anodized, therefore; do not use abrasive materials to remove the corrosion. Use only the fine brush with alcohol or detergent. Also, clean all aluminum shavings around the threads of the filter holder rings.

4. Reassemble the unit in accordance with previous scribed match marks. Take particular care to ensure that all the "O" ring seals are properly placed and that all screws are uniformly tightened.

   NOTE: The "O" rings in the aerosol inlet should be removed each quarter and conditioned with vacuum grease. This will inhibit breakdown and fraying of the "O" ring caused by friction on the inlet tube. The bug screen protecting the aerosol sampler inlet should be cleaned periodically during the summer months. The bug screen is exposed for cleaning by pulling the sampler inlet off the receiver tube assembly. An "O" ring in the sampler inlet acts as the seal. The samplers are equipped with an inlet that also has a primary water trap on the exterior of the unit. This trap is glass, and care should be taken not to crack or break it, as the sampler will not maintain adequate vacuum during operation. The glass trap may be either replaced with a plastic jar or wrapped with insulating tape to minimize the danger of accidental breakage.

Virtual Impactor Assembly

Internal particulate deposits accumulate primarily on the outer and inner surfaces of the tip (closest to sampler inlet) of the inlet tube. Thus, the inlet tube should be inspected and cleaned each quarter for such particulate deposits; the remaining surfaces should be cleaned every 6 to 12 months. Use alcohol or water and a soft-bristle brush for cleaning.

Examine sample module vacuum tubing quarterly for crimps, cracks, or breaks and replace as necessary. Examine connecting fittings for cross-threading, and replace fittings as necessary.

M.1.3.3 CONTROL MODULE

CAUTION: UNPLUG THE POWER CORD FROM ITS RECEPTACLE BEFORE REMOVING OR OPENING THE FRONT PANEL OF THE DICHOTOMOUS CONTROL PANEL.

1. Open the front panel and blow out loose dust and dirt if compressed air is available. Wipe down all surfaces with general purpose cleaner and towels.

2. Make note of any obvious problems in the unit and take action to correct them before completion of cleaning.

3. Check rotameters for cleanliness. If they are dirty and/or contain water, they must be removed and cleaned. If water is found, the interior of the vacuum pump may be damaged. It should be opened for inspection and possible repair.

   NOTE: Water may be formed by the condensation action of the compressed air. If a gas containing water vapor is compressed at a constant temperature, the water vapor is also compressed until its pressure equals the vapor pressure of water at that temperature. At this point, the gas is saturated with water vapor; or at 100% relative humidity. To minimize this action, the output pressure of the pump has been set to 4 PSIG $\pm$1 PSIG. The pump pressure is adjusted by the flow controller valve and should not be adjusted during field operations.

   To clean rotameters, take the following steps:

   a. Remove the tubing from the total rotameter output port and any other connecting tubing that may prove to be too inflexible to allow removal of the rotameters.

   b. Remove the screws securing the rotameter assembly to the front panel.

   c. Slip the assembly back from the front panel to gain access to the Allen screws in the top of each rotameter and remove the protective cover.

   d. While holding the glass rotameter with one hand, loosen the Allen screws just enough to allow removal of each of the graduated glass tubes.

   e. Clean the two rotameters with the alcohol or water and detergent and rinse thoroughly in distilled water. For proper cleaning of the unit, the float and its retainers also should be removed. The retainers are easily removed with the aid of a wire hook fashioned from a paper clip.

   f. Allow the tubes to dry thoroughly and reassemble.

4. Remove and clean all filter jars. Check each for possible cracks, and replace as necessary. Should a filter jar become cracked or loosened, the dichotomous sampler will not maintain an adequate vacuum during leak tests. Be certain that each filter jar is tightened and properly secured. Clean or replace any dirty filter elements. These elements become dirty in routine operation or if the sampler is inadvertently energized without sample filters installed.

5. Clean the cooling fan's blades and housing with compressed air or a small brush. Check the housing for any dirt that could cause the fan to hang up.

6. Clean the exterior surfaces of the vacuum pump; be sure that all cooling vents are open. Take care that fluids do not run inside the pump.

7. Check all mounting brackets to ensure that they are tight and in good condition.

8. When all cleaning and routine maintenance operations have been completed, close the control module, reassemble the sample module, and recalibrate the instrument at the six- month interval (see Table M.1.2.1). Refer to Sections M.2.1.2 and M.2.1.3 for calibration procedures.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX M.2

CALIBRATION PROCEDURES

FOR

DICHOTOMOUS SAMPLER

MONITORING AND LABORATORY DIVISION

FEBRUARY 1997

M.2.0 OVERVIEW

M.2.0.1 INTRODUCTION

Calibrations of the rotameters and operational accuracy checks of the other components of the dichotomous sampler are required upon installation and every six months thereafter. The primary purpose of the calibration is to determine and/or to verify the set points to maintain the actual total flow at 16.7 liters per minute (lpm), coarse flow at 1.67 lpm and fine flow at 15.03 lpm.

NOTE: Model 241 with Dickson Recorder - Dickson is used as a quality control tool and to verify flows and a full 24-hour run. Actual flow calibrations are made with the sampler rotameters.

M.2.0.2 APPARATUS

1. Transfer standard mass flow meters: ranges 0 - 3 slpm and 0 - 30 slpm
2. 1/4" Teflon tubing - 3 meters long
3. Total flow adapter
4. 110 VAC wall clock or standard digital watch
5. Adjustable wrench (6) inch
6. One-quarter inch brass cap
7. Blank filter cassettes (fine and coarse)
8. MSA Filter with 3/8" Adapter

M.2.1 CALIBRATION

M.2.1.1 PRECALIBRATION SYSTEM CHECK

Procedures for the precalibration system check are as follows:

1. Place a pair of filters into the dichotomous sampler filter holders. Filters used for flow rate calibrations should not be used for subsequent sampling.

2. Remove the sampler's inlet. Turn on the sampler and allow it to warm up to full operating temperature (at least 5 minutes).

   NOTE: Do NOT leak check the system prior to the completion of an "AS IS" calibration. A precalibration leak may invalidate an "AS IS" by exerting high vacuum on weak or leaky tubing.

3. Perform a system leak check by opening both rotameters completely and sealing the inlet tube with a rubber stopper or duct tape. When maximum indication of total vacuum is reached, shut off power to the unit, record the maximum reading on the datasheet, and observe the rate of decline in the readings of the vacuum gauges.

   NOTE: Leak-free systems should indicate a vacuum of 10 to 15 inches Hg or more, and the rate of decline to 0 inch Hg should require 60 seconds or more. If these conditions are not met and the control module was successfully leak-tested previously, a leak exists either in the interconnecting tubing or in the sample module.

   Filter jars are often leakage areas and some pumps tend to leak. A leaky pump can be identified by plugging the output port marked "OUT/CALIBRATE" immediately after turning the pump off. If the rate of decline is slowed to zero inches Hg in about 60 seconds, the system is considered pneumatically acceptable.

4. Open the inlet tube and apply power.

M.2.1.2 TOTAL FLOW ROTAMETER CALIBRATION

Procedures for calibrating the total flow rotameter are as follows:

1. Set up calibration system as illustrated in Figure M.2.1.4. The inlet of the transfer standard is open to ambient air; the outlet of the transfer standard is connected to the inlet tube of the dichotomous sampler.

2. Turn on the sampler and allow it to warm up to normal operating temperature (at least 5 min.). If an electronic transfer standard is used, it must also equilibrate before proceeding with the calibration.

3. Adjust the total flow (Qt) valve to approximately 90% of the rotameter scale. Adjust the coarse flow control (Qc) valve to indicate a nominal flow of 1.67 liters per minute (lpm). If the nominal value is unknown, adjust the coarse flow to 50% scale. Using the total flow adjustment valve, vary the total flow to five different rates, approximately 20, 18, 16, 14, and 12 lpm.

4. Record the rotameter indication and corresponding transfer standard output for each flow rate on the calibration datasheet (see Figure M.2.1.1), or if applicable, the newer lap-top computer print out form.

M.2.1.3 COARSE FLOW ROTAMETER CALIBRATION

1. Turn off the sampler, disconnect the fine flow vacuum line (3/8 in. o.d. tubing), and cap the fine flow output port with a 3/8 in. cap, (see Figure M.2.1.5). This step keeps the fine flow line open to the vacuum pump. It is recommended that a particle-free filter, such as an MSA filter with 3/8 inch adapter, be attached to the detached fine flow line to prevent particles from entering the system. Install the coarse flow rate transfer standard.

2. Energize the sampler. Allow the sampler to warm up again to full operating temperature.

3. Adjust the coarse rotameter flow-control valve to an approximate value of 90% of the rotameter scale. Adjust the total flow control valve to indicate a nominal flow of 16.7 lpm. Adjust the coarse flow adjustment valve to five different rates, approximately 2.0, 1.8, 1.6, 1.4, and 1.2 lpm.

4. Record the rotameter indication and corresponding transfer standard output on the calibration datasheet (see Figure M.2.1.1), or lap-top computer as applicable.

5. Turn off sampler and reconnect the fine flow line. Turn sampler on and again measure total flow (Qt). This value will be used to calculate fine flow (Qf) rate where: Qf=Qt - Qc.

NOTE: Before leaving the site a comparison between the flows determined should be made (i.e., fine + coarse = total). If the sum of the individual flows (fine and coarse) does not equal the total flow (within ±2%), the data should be rechecked.

6. Prepare calibration graphs for as is total and coarse flows (reference flow meter vs. rotameter readings). If a leak was detected, additionally prepare final calibration graphs for total and coarse flows with leak corrected. Record corresponding rotameter set points for total flow of 16.7 actual lpm and coarse flow of 1.67 actual lpm from the final graphs on the Calibration Datasheet. (See graphs in Figures M.2.1.2 and M.2.1.3.). Computer-generated graphs will apply to those stations utilizing lap-top computer data entry.

7. Compute the as is changes in total and coarse flows at the previous setpoints:

Change in total flow rate, %

$$= \frac{\text{Total flow rate in actual lpm at previous total flow setpoint} - 16.7}{16.7} \times 100\%$$

Change in coarse flow rate, %

$$= \frac{\text{Total flow rate in actual lpm at previous total flow setpoint} - 1.67}{1.67} \times 100\%$$

M.2.1.4 ALTITUDE CORRECTION FACTOR

In order to maintain the 2.5 and 10 micrometer cutpoints, the flow rate of the dichotomous sampler must be adjusted to 15.03 actual lpm and 1.67 actual lpm for the fine and coarse cuts, respectively. Dichotomous samplers operating at altitudes over 1000 feet must have corrections for altitude incorporated into the calibration procedure and the sampler air flow calculations. Refer to the calibration datasheet (Figure M.2.1.1), or lap-top computer data screen as applicable.

Since the rotameter set points must be determined from a calibration of standard lpm versus rotameter setting, the transfer standard mass flow meter data must be corrected from standard lpm to actual lpm by applying the altitude correction factor (ACF) as listed in Table E.2.0.1, in Appendix E, Volume II of this manual. Or, the ACF is calculated as [0.999 x exp (-.0000371) x Altitude, feet)] for samplers operating above 1000 feet. At altitudes equal to or less than 1000 feet the ACF is 1.0. Note that ACF is less than or equal to 1.

NOTE: To calculate the coarse and fine filter mass loadings (grams per standard lpm) for the collected samples, it is necessary to reconvert the measured flow readings in actual lpm to standard lpm as discussed in Section M.1.1.5.

Sample Altitude Correction Calculations:

Assuming the dichotomous sampler is located at 7800 feet altitude, determine the total and coarse flows in standard liters per minute (slpm) corresponding to the actual total and coarse flows of 16.7 lpm and 1.67 lpm, respectively.

From Table E.2.0.1, Appendix E, Volume II of this manual, the ACF = 0.748

Therefore; standard lpm = Actual lpm x ACF
total slpm = 16.7 x 0.748 = 12.5
coarse slpm = 1.67 x 0.748 = 1.25

CALIFORNIA AIR RESOURCES BOARD
DICHOTOMOUS SAMPLER (VIRTUAL IMPACTOR) CALIBRATION DATA SHEET

Site Name MAMMOTH LAKES Calibration: As Is [X] Final [ ]
Site No. 26-795 Date 4/18/91 Log N. ______
Site Temperature ______ Barometric Pressure ______
Site Elevation 7800 (Feet) Altitude Correction Factor* 1/1.3372 = 0.7478

* ACF = .999 x exp (.0000371x Altitude, ft.) if altitude >1000 feet; otherwise = 1.000 (Note: ACF ≤ 1).

ANALYZER IDENTIFICATION
Dichotomous Sampler Make and Model SIERRA ANDERSON SERIES 240
Property No. 5830 Serial No. 421-143 Head Cutpoint 2.5 / 10 μ

TRANSFER STANDARD MASS FLOW METER IDENTIFICATION
Make and Model TYLAN 4 cal Property No. 9410
Certification Date 4/91 Certification Expires ______
Certification Equations:
Total Flow (Pos. # 3): Air Flow = Display x 0.9935 ± 0.1694 slpm
Coarse Flow (Pos. # 2): Air Flow = Display x 1.0942 ± 0.0369 slpm

TOTAL FLOW CALIBRATION				COARSE FLOW CALIBRATION			
Rotameter Reading	Transfer Std Reading	SLPM	LPM	Rotameter Reading	Transfer Std Reading	SLPM	LPM
80	19.07	19.09	25.53	70	1.95	2.10	2.61
70	16.40	16.45	22.00	60	1.765	1.83	2.28
60	13.75	13.82	18.49	50	1.475	1.59	1.97
50	11.10	11.19	14.96	40	1.255	1.34	1.68
40	8.47	8.59	11.48	30	0.995	1.05	1.33
30	5.90	6.05	8.06	20	0.725	0.76	.970
As Is Checks At Previous Setpoints	Total Airflow = 12.52 SLPM			% Dev. from Previous -1.7 %			
	Coarse Flow = 1.34 SLPM			% Dev. from Previous +7.2 %			

Total Flow: Set Point = 54 = 16.7LPM x 0.7478 (ACF) = 12.49 slpm

Linear regr: Airflow = 0.2615 x Rotameter Reading ± 1.852 slpm

Coarse Flow: Set Point = 38 = 1.67LPM x 0.7478 (ACF) = 1.249 slpm

Linear regr: Airflow = 0.0215 x Rotameter Reading ± 0.250 slpm

Comments: ______

Calibrated by GCA Checked by FE

Figure M.2.1.1
Dichotomous Sampler Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD
CALIBRATION GRAPH

Log No.: ______

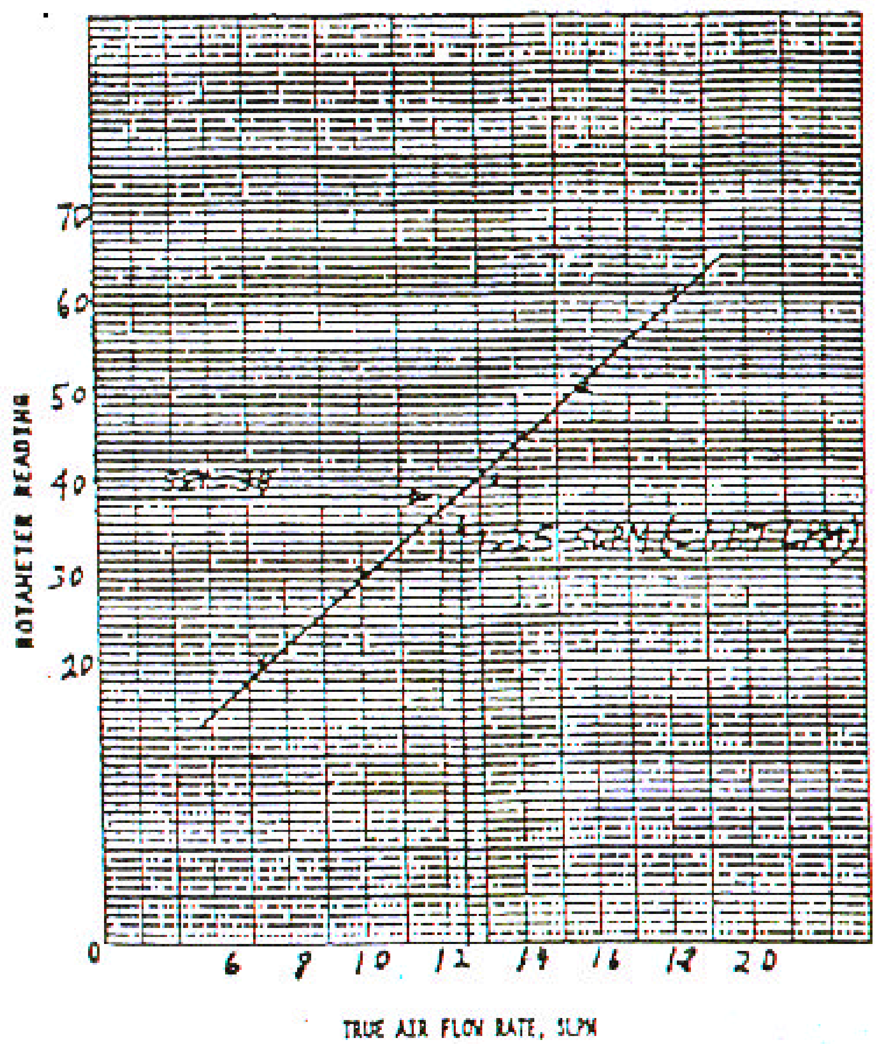
Station Name: MAMMOTH LAKES Date of Calibration: 4-18-91

Station Site No: 26-785 "As Is" Calibration: ______

Instrument Property No: 5830 "Final" Calibration: ✓

Instrument Make and Model No: SIERRA 240

Rotameter Reading: ☒ Total ○ Coarse



COMMENTS: ______

MLD-24 (7/91) Graph Prepared by: RS

Figure M.2.1.3
Dichotomous Sampler Calibration Graph-Total Flow

CALIFORNIA AIR RESOURCES BOARD
CALIBRATION GRAPH

Log No.: ______________

Station Name: MAMMOTH LAKES

Date of Calibration: 4-18-91

Station Site No: 26-785

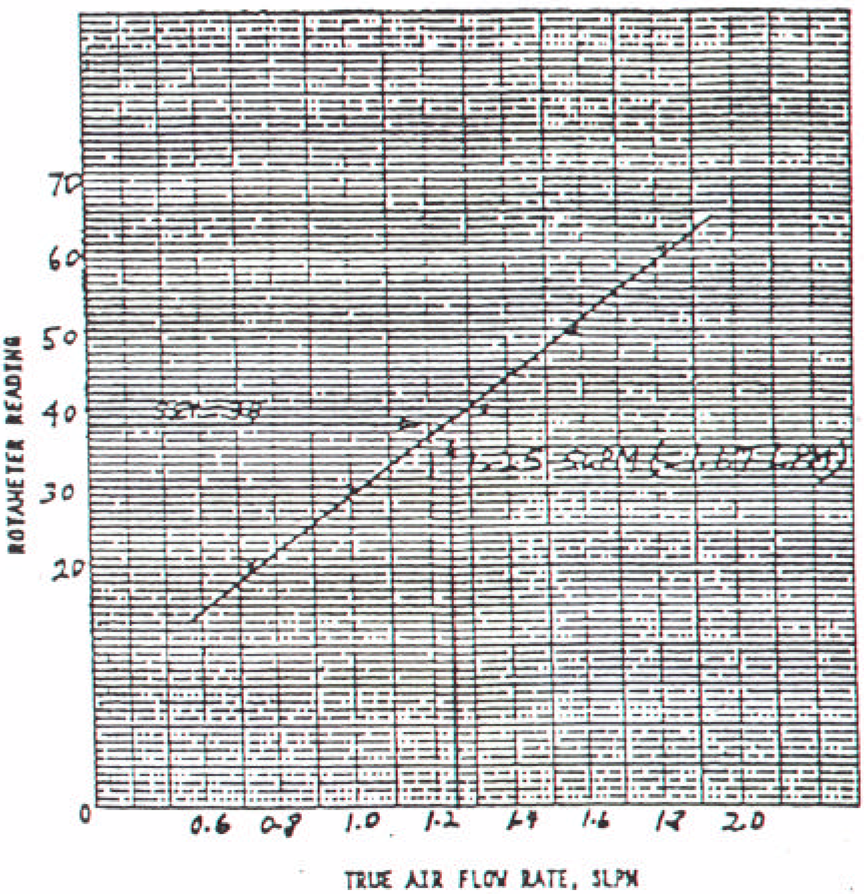
"As Is" Calibration: ________

Instrument Property No: 5830

"Final" Calibration: ✓

Instrument Make and Model No: SIERRA 240

Rotameter Reading: ☐ Total ☒ Coarse



COMMENTS: ____________________

MLD-24 (7/91)

Graph Prepared by: R.S.

Figure M.2.1.3
Dichotomous Sampler Calibration Graph-Coarse Flow

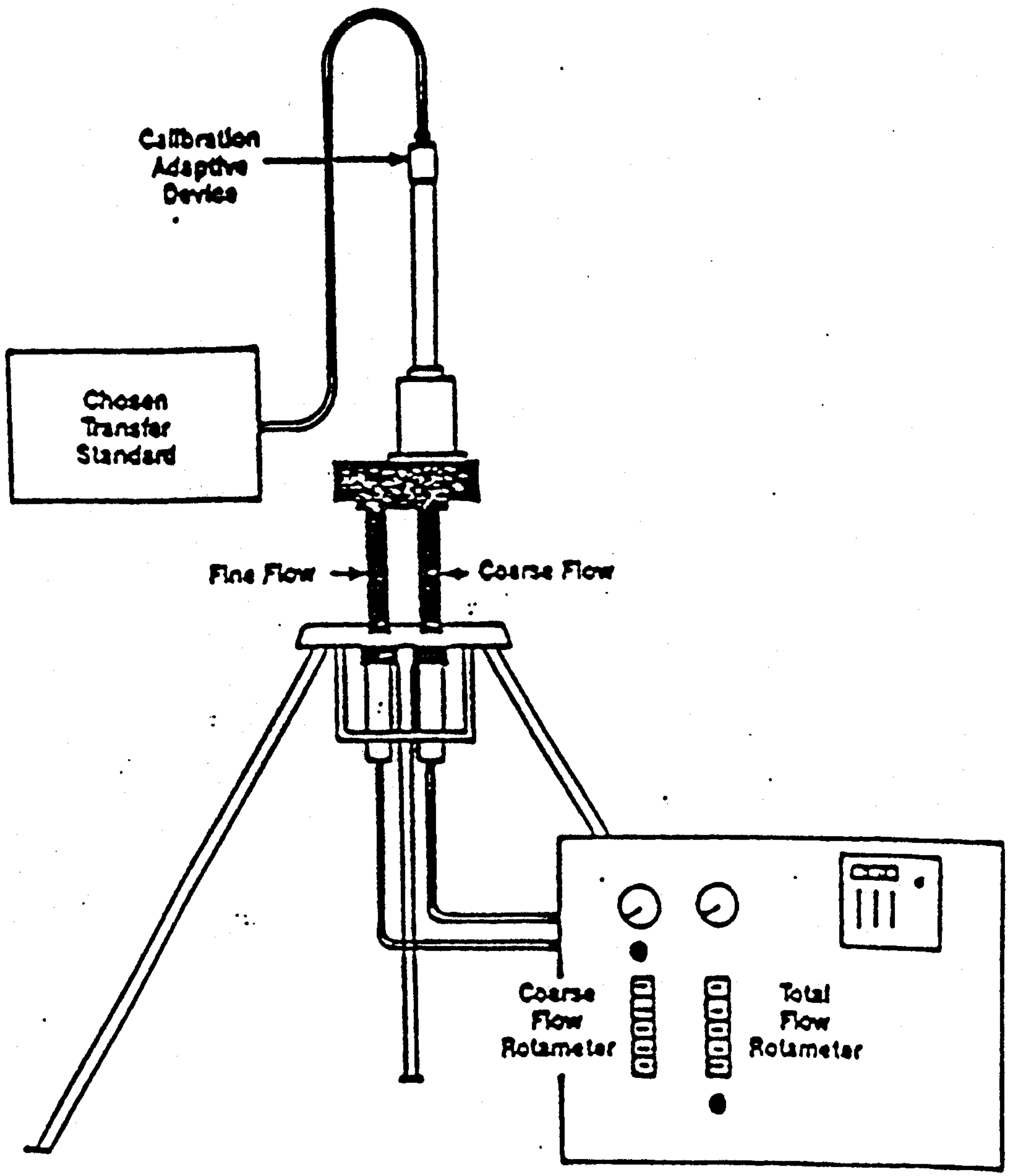


Figure M.2.1.4
Calibration Assembly and Dichotomous Sampler
with Transfer Standard Connected

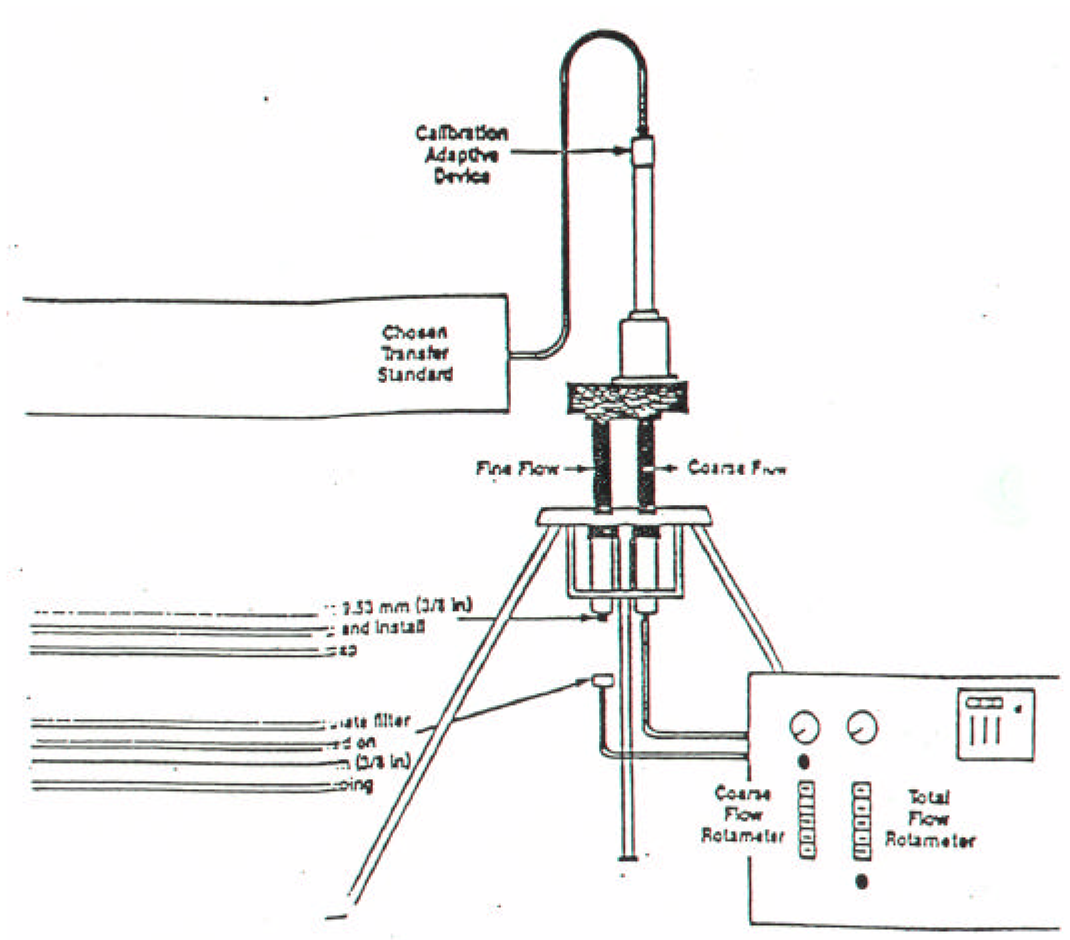


Figure M.2.1.5
Calibration Assembly and Dichotomous Sampler Set Up to Calibrate
the Coarse Flow Rotameter

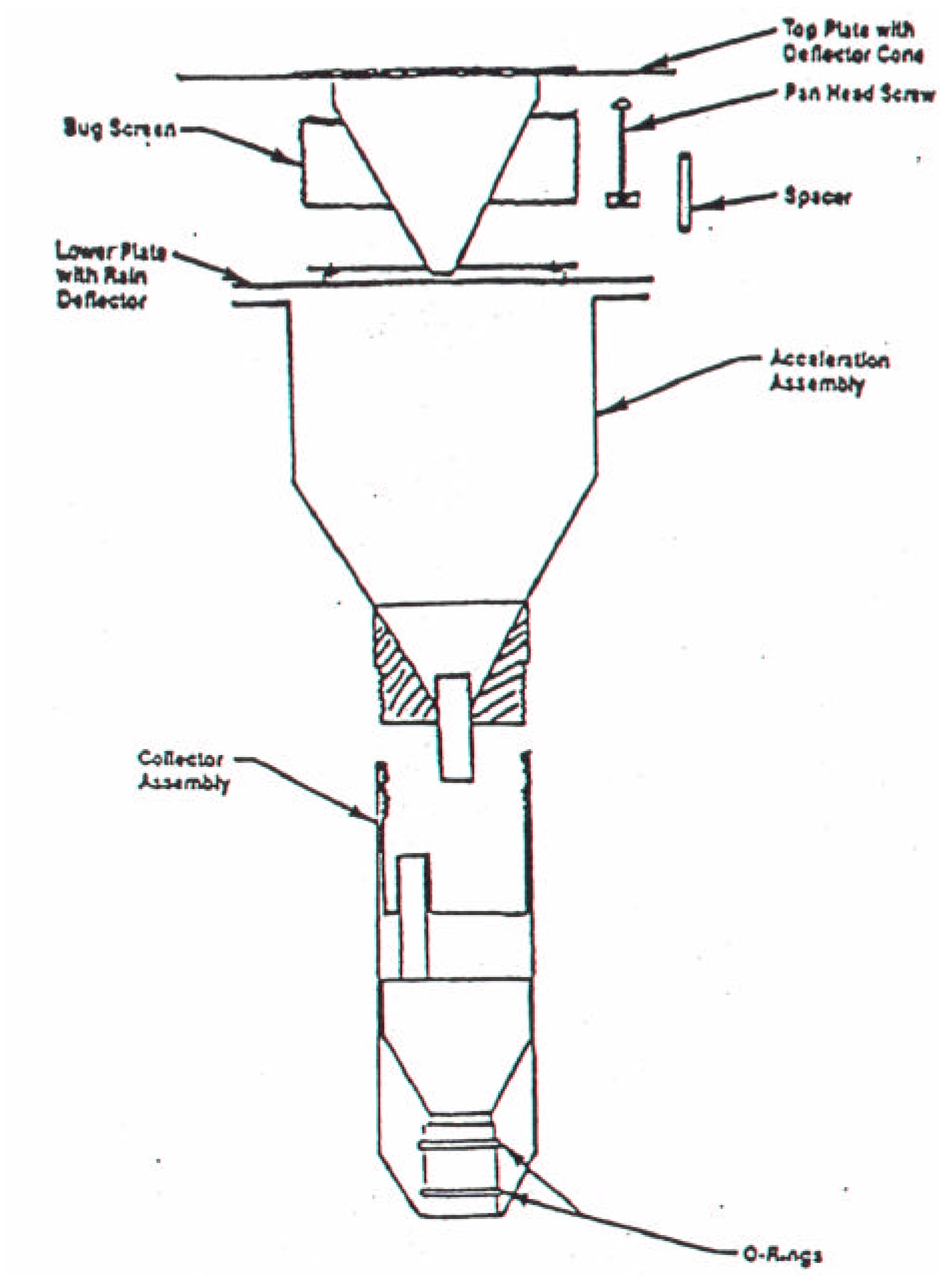


Figure M.2.1.6
Dichotomous Sampler Inlet

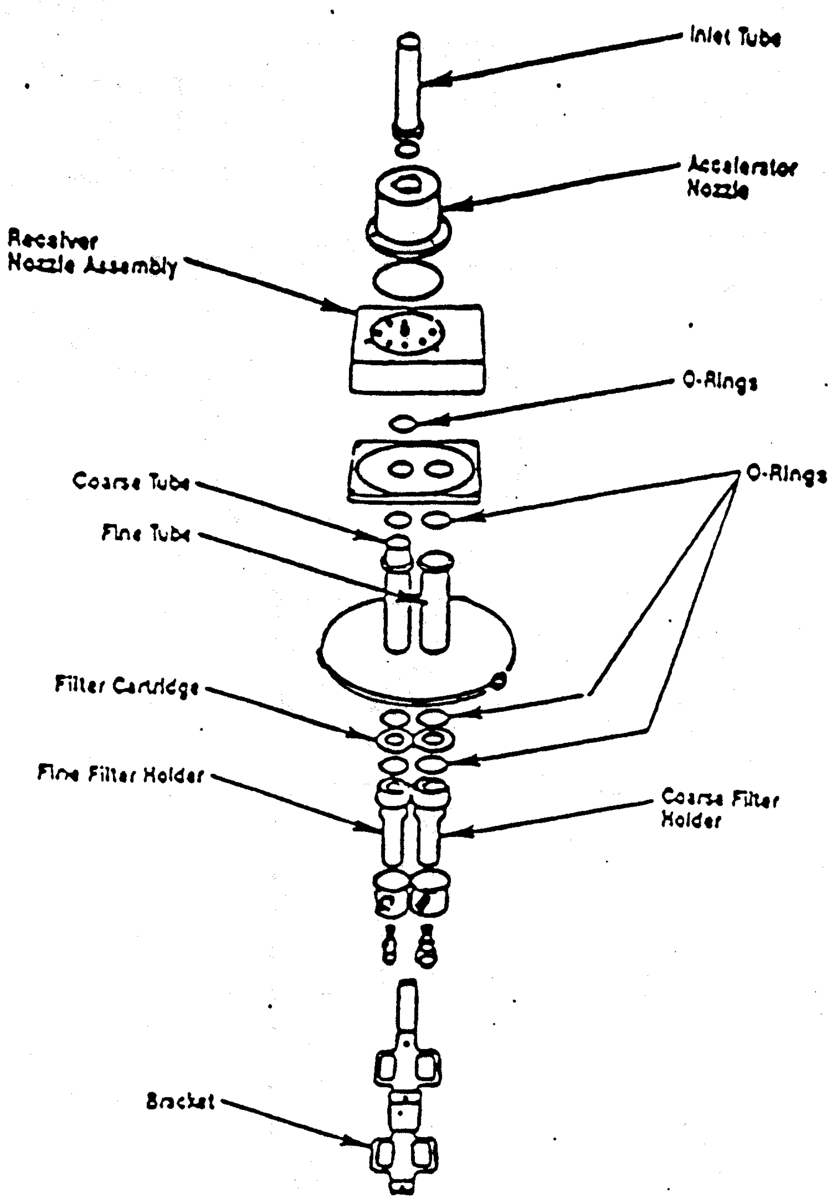


Figure M.2.1.7
Dichotomous Sampler Virtual Impaction Assembly